Semiannual Progress Report of Research Performed
Under NASA Grant NGR 17-003-003, Supplement 1

INVESTIGATION OF FLOW FIELDS ABOUT DELTA AND DOUBLE-DELTA WINGS AT LOW SPEEDS

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Delta and double-delta wing velocity field data obtained under the first phase of the grant is being analyzed in greater detail. Integrals of the velocity-field maps are being made to determine circulation. The resultant circulation values are being compared with measured lift values as well as with circulation values obtained using several delta wing lift theories.

During November the principal investigator made a coordination trip to NASA Ames Research Center. As a result of this trip, it was learned that the principal aerodynamic effects of the double-delta strake reported in WSU AR 65-2 are in substantial agreement with flight test results obtained by NASA with a modified F5D aircraft (as reported in AIAA Paper 65-782).

A visit was also made to Vidya Corporation to coordinate with Dr. Alvin Sachs and Mr. Ray Lundberg, who are working on delta wing theory under NASA sponsorship. A fundamental experimental measurement in which the Vidya personnel expressed great interest is the vortex sheet strength generated at the sharp leading edge. Knowledge of this vortex sheet strength is essential to the development of a theory for the nonlinear

lift developed by such wings.

Cross-flow (two-dimensional) theory utilizing free-streamline techniques predicts a value approximately half as large as the experimental measurements reported by Smith & Fage (Ref. Goldstein, "Modern Developments in Fluid Mechanics", Volume II, page 555) for a two-dimensional sharp-edged plate. Vortex sheet strength measurements for a highly swept leading edge have not been reported in the literature, as far as the principal investigator can determine. Measurements of this type will be attempted, therefore, using the velocity probe and wing models on hand. These measurements will require a special mounting of the probe, directly on the wing panel. If the measurements are successful, a parametric investigation of vortex sheet strength as a function of sweep angle and angle of attack would be a logical step toward providing sufficient information to develop a complete wing theory.

A coordination visit was also made with Lockheed-Burbank personnel during November. Low-speed wind tunnel force data obtained by Lockheed was found to compare quite favorably with data reported in WSU AR 65-2.

Additional flow field measurements are being obtained using the wing models previously tested. The regions beyond the wing tip are being explored in more detail, and some mapping is being carried out downstream from the trailing edge to ascertain the rapidity of vortex sheet roll-up.

The existing delta and double-delta wing models have been modified to provide for leading-edge droop in order to attempt to reduce the induced drag by obtaining additional leading-edge suction force. The undeflected leading-edge configurations developed a very small leading-edge suction (Ref. AR 65-2, pages 136-137). Influence of leading-edge deflection on flow fields will also be determined.

A non-rotating vorticity probe to utilize small strain-gaged vanes is being developed. This probe would permit direct measurement of vorticity in the vicinity of wings of the type being investigated without the frictional errors associated with rotating vane type vorticity meters. This should be very helpful in determining the position of the vortex sheets as they interact and roll up over the upper wing surface. Progress on construction of this probe has been slow due to machining difficulties.